Title	Atmospheric observations with a ship-borne lower troposphere radar(RECENT RESEARCH ACTIVITIES)
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Citation	Sustainable humanosphere : bulletin of Research Institute for Sustainable Humanosphere Kyoto University (2007), 3: 7-7
Issue Date	2007-08
URL	http://hdl.handle.net/2433/51022
Right	
Type	Departmental Bulletin Paper
Textversion	publisher

Atmospheric observations with a ship-borne lower troposphere radar

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Wind profilers are a powerful tool to obtain vertical profiles of three components of wind velocities and are widely used for not atmospheric researches but also operations for weather prediction. However observation data over the sea are still insufficient. We have developed a wind profiler for lower tropospheric observations over the sea (Ship-Borne Lower Troposphere Radar: SB-LTR), based on the L-band (1357.5 MHz) lower troposphere radar [1], which we previously developed. The SB-LTR was installed to the oceanographic research vessel MIRAI of JAMSTEC, Japan for test observations in March, 2004 (MR04-01), in December, 2004-January, 2005 (MR04-08), and in October-November, 2006 (MR06-05).

The SB-LTR system consists of five parts, which are a phased array antenna, an active module unit, a transmitter/receiver unit, a data acquisition unit, and a signal processing unit. An electromagnetic coupling coaxial dipole antenna is used as the antenna element [2]. The antenna can be divided into four sub-antennas. It is possible to operate the radar using one sub-antenna (whose size is 2 m x 2 m) for utilization in a relatively small installation space. It is possible to vary the beam direction by electronically steering the zenith angle within 45 degrees. A peak output power of 2 kW is obtained by 24 active transmitting modules.

The overview of the SB-LTR is shown in Figure 1. All equipment except for the antenna was stored in a container to avoid salt damage. A GPS navigational sensor and a three-axis angular sensor were deployed to provide necessary adjustments to wind profiles. During the observation, antenna beams were steered to vertical and 4 oblique directions with the zenith angle of 10 degrees. One cycle for 5 directions took about 2 s. Sub-pulse length was 1 us, which corresponds to the range resolution of 150 m. Time series complex data after conducting pulse-decoding and 64 coherent integrations were stored every 3.2 ms. The data such as roll, pitch, direction, speed, latitude, longitude of the ship simultaneously obtained were also stored for off-line analysis. Using the direction of ship head and the velocity vector of ship, we estimated wind profiles in stationary system. Figure 2 shows time-height cross-section of zonal winds observed with SB-LTR in MR04-08. Westerly wind was changed to easterly wind around December 24. During this period, a few MJO passed over, but the precipitation was not observed so frequently. In spite of relatively dry condition above 2 km (not shown), we could obtain wind profiles up to about 5 km.

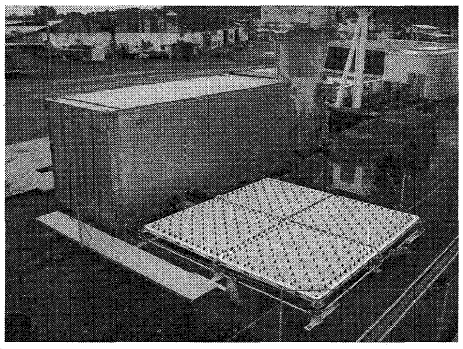

Figure 1. Overview of SB-LTR in MR04-08 cruise.

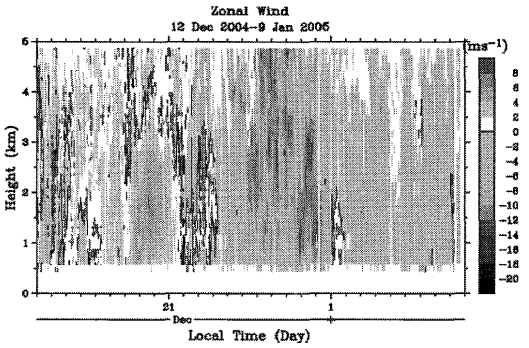

Figure 2. Time-height cross-section of zonal winds observed with SB-LTR during December 12, 2004-January 9, 2005.

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